Keyed bonding between connectors and contacts on a semiconductor surface - uses an intermediate layer with structured melting point to fuse connector to solar cell contact under heat and pressure

Publication number: DE4241439

Publication date: 1994-06-16

Inventor: PCHALEK NORBERT DIPL PHYS (DE); WILDE JUERGEN DR ING (DE)

Applicant: DAIMLER BENZ AG (DE); DEUTSCHE AEROSPACE (DE)

Classification:

- International: ***B23K35/00; H01L31/0224; H01L31/05;*** **B23K35/00; H01L31/0224; H01L31/05;** (IPC1-7): H01L21/60; B23K35/22; H01L23/488; H01L31/0224; H01R43/02

- European: B23K35/00B; B23K35/00B8; H01L31/0224B2; H01L31/05

Application number: DE19924241439 19921210

Priority number(s): DE19924241439 19921210

Abstract of **DE4241439**

A keyed connection is formed between metal connectors and metallic contacts for semiconductor surfaces, by placing an intermediate layer of low melting metal between the connector and the connection, which are of higher melting materials, and they are brought together. Heat and pressure are applied, hotter than the melting temp. of the intermediate layer, to give a molten layer over the two surfaces to be bonded. The molten intermediate layer is diffused into the connector and contact as an intermetallic phase. The joint is cooled during the preset temp. and pressure for setting, and the keyed joint between the connector and contact at a melting temp. higher than the original intermediate layer. The intermediate layer is a metal with a melting point lower than 450 deg.C, such as Bi, Cd, Ga, In, Pb, Sn or Zn. The connectors and contacts are of metal such as Ag, Au, Cu, Co, Fe, Mn, Ni, Pd, Pt, Ir, Os, Re, Rh or Ru. USE/ADVANTAGE - The method is especially for bonding connectors and contacts at semiconductor surfaces for series and/or parallel circuits of solar cells. The joints are effected easily, and they have a long life especially when subjected to wide changes of temp.

Europäisches Patentamt
European Patent Office
Office européen des brevets

Description of DE4241439	Print	Copy	Contact Us	Close

Result Page

[0001] The invention relates to a method to the production of a positive connection between metallic fasteners and metallic contacts of semiconductor surfaces, in particular of to the series and/or parallel flow of solar cells serving fasteners and solar cell contacts.
[0002] It is well-known to interconnect metallic fasteners and metallic contacts of semiconductor surfaces by soldering or welding method. While it is with such, by plumb llnes manufactured connections from disadvantage the fact that this it cannot be exposed to a high temperature load and only few temperature changes is unfavorable it with welded connections that the semlconductors are subject to relatively large pressing pressures and due to the high welding temperatures a temperature shock.
[0003] The invention is the basis the task to create a method for the production of a reliable positive connection between metallic fasteners and metallic semiconductor contacts which a long life exhibits and a large number of temperature changes gets over.
[0004] The task is solved according to invention by the following process steps:

a) between a fastener and a contact an intermediate layer made of a metal lowmelting opposite the fastener and metallic contact is arranged,
b) by the higher-melting connector, the lowmelting intermediate layer and the higher-melting contact are brought with one another in contact and under a given temperature and contact pressure process up and/or. over the fusing temperature of the intermediate layer it warms up in such a manner that the liquid intermediate layer moistens the adding surfaces of fastener and contact,
c) that by diffusion of the infinitesimal liquid intermediate layer in the fastener and contact an intermetallic phase is formed by the material of the intermediate layer and the fastener and contact which can be added, and
d) that by cooling down and solidification during the given temperature and contact pressure process the positive connection between fasteners and contact is finally made, whose fusing temperature is higher, as those the original intermediate layer.

[0005] The method according to invention, which isotherm solidification is called, cannot be assigned as joining processes clearly the soldering or to the welding processes. Procedure principle is the production of a positive connection between two adding partners made of higher-melting metals with help of an infinitesimal liquid intermediate layer made of a lowmelting metal. The trial process is clarified by the example of the system cu-SN-cu. The copper parts provided on the coplanar joining areas with thin coatings of tin are brought to Ts of the tin in contact and warmed up over the bloom temperature. The thin fusion layer moistens the jointing parts. By diffusion of tin in copper first the intermetallic phase Cu3Sn under consumption of the fusionliquid phase forms. Thereby a solid connection develops. With further temperature influence, for the example with the use of the manufactured solid connection under increased temperatures, the intermetallic phase with higher cu content, Cu6Sn5 is then formed.
[0006] The method according to invention brings the following advantages with itself:

▲ top
- Contacting at low temperatures from 160 to 450 C, which correspond to that plumb lines.
- High Temperaturstabilität of the connections, since the fuslng temperature Ts intermetallic phases lies around 100 to 300 K over the adding temperature.
- Value strength of the connections because of small ductility of the intermetallic phases.
- Small one mechanical load of the parts by small contact pressure.

[0007] The search for suitable binary systems consisting for the above method, of a high and a lowmelting metal, was made under the boundary conditions of the contacting of solar cells, whereby the following criteria were considered:

- < smallest melting point of the system Ts; 400 C,
- Formation of highly alloyed mixed crystals and/or. intermetallic phases,
- Completeness of the system, and led to it that in accordance with arrangements of the method according to invention as lowmelting intermediate layer metals with a melting point are used under 450 C, like Bi, CD, Ga, in, Pb, SN or Zn, and that as higher-melting fasteners and contacts metals are not used such as AG, outer one, cu, CO, Fe, Mn, ever, Pd, Pt, IR, OS, RH, RH or Ru.

[0008] Further arrangements of the method according to invention go by that the fusing temperature and the given contact pressure are applied by means of a pressure heating time apparatus, whereby an apparatus with a pressing surface of 0.5 mm to be used it knows 7 mm, whose temperature range from 100 to 500 C is adjustable around 3K, or there that the fusing temperature in a furnace is applied when simultaneous applying the contact pressure by means of a mechanical Druckvorrichtung.
[0009] The method according to invention with its inventive arrangements is suitable in favourable-proves for the preparation of connections between thin sections. Here the growth of the formed intermetallic phases takes place in pairs of thin sections not in even front, but in form more burl-like (CuSn) or more stengeliger (NiSn) single crystals. It becomes approach by a parabolic law in form

= the k t< n>
described, whereby the values of n for Cu6Sn5 with n = 0.2 to 0.4, with Ni3Sn4 with approx. 0,5 lies. The deviations from the law through over stored volume and grain boundary diffusion caused.
[0010] To the preparation of positive connections between to the series and/or parallel flow of solar cells serving fasteners and solar cell contacts for example two different systems are usable. The first system exhibits a fastener with a metallic carrier from molybdenum and an adding surface from silver as well as a solar cell contact from silver and an intermediate layer from tin. However the second system consists of a fastener with a silver carrier with an adding surface of gold, a solar cell contact of gold as well as an intermediate layer of indium. The making takes place after the above-mentioned process steps A to D, whereby the fastener, the intermediate layer and the contact to one the soldering temperature corresponding fusing temperature of the respective intermediate layer within a range from 160 to 325 C for one period of 1 to 10 min are warmed up, and whereby for this period given contact pressure between fasteners, intermediate layer and contact between 10 and 100 Newton amounts to.
[0011] An arrangement of the invention consists of the fact that before the intermediate layer a thin diffusion barrier layer is separated, which a reaction between carrier metal and the intermediate layer during the storage prevented and thus an improvement permits the shelf-life.
[0012] Here the use becomes 6 to 10 as inventive further training thicken silver contact layer on the solar cell surface as well as the use of a layer thickness of the tin intermediate layer, the 1 to 2 amounts to outstanding.
[0013] A special arrangement of the invention is characterised in that the intermediate layer from tin and/or. However indium on the adding surface of the fastener from silver or from gold (in accordance with Unteranspruch 12) is applied or on the adding surface of the solar cell contact from silver or from gold (in accordance with Unteranspruch 16) locally. Like that a local applying of the intermediate layer is possible by means of photoresist technology (photoresist technology) or by a vaporization or by galvanic shop by means of mask technology on the adding surface of the fastener or the solar cell contact.

Europäisches Patentamt
European Patent Office
Office européen des brevets

Claims of DE4241439	Print	Copy	Contact Us	Close

Result Page

Notice: This translation is produced by an automated process; it is intended only to make the technical content of the original document sufficiently clear in the target language. This service is not a replacement for professional translation services. The esp@cenet® Terms and Conditions of use are also applicable to the use of the translation tool and the results derived therefrom.

. Method to the production of a positive connection between metallic fasteners and metallic contacts of semiconductor surfaces, in particular of to the series and/or parallel flow of solar cells serving fasteners and solar cell contacts, characterized by the following process steps:
a) between a fastener and a contact an intermediate layer made of a metal lowmelting opposite the fastener and metallic contact is arranged,
b) the higher-melting connector, the lowmelting intermediate layer and the higher-melting contact are brought with one another in contact and under a given temperature and contact pressure process up and/or. over the fusing temperature of the intermedlate layer it warms up in such a manner that the liquid intermediate layer moistens the adding surfaces of fastener and contact,
c) that by diffusion of the infinitesimal liquid intermediate layer in the fastener and contact an intermetallic phase is formed by material of the intermediate layer and the fastener and contact which can be added, and
d) that by cooling down and solidification during the given temperature and contact pressure process the positive connection between fasteners and contact is finally made, whose fusing temperature is higher, as those the original intermediate layer.

2. Process according to claim 1, characterised in that as lowmelting intermediate layer of metals with a melting point under 450 C to be used, like Bi, CD, Ga, in, Pb, SN or Zn.
3. Process according to claim 1, characterised in that as higher-melting fasteners and contacts of metals such as AG, outer one, cu, CO, Fe, Mn, never, Pd, Pt, IR, OS, RH, RH or Ru to be used.
4. Process according to claim 1, 2 or 3, characterised in that the fusing temperature and the given contact pressure by means of a pressure heating time apparatus to be applied.
5. Process according to claim 4, characterized by the use of a pressure heating time apparatus with a pressing surface of 0.5 mm 7 mm, their temperature range from 100 to 500 C over 3K is adjustable.
6. Process according to claim 1, 2 or 3, characterised in that the fusing temperature in a furnace when simultaneous applying the contact pressure by means of a mechanical Druckvorrichtung is applied.
7. Process according to one of claims 1 to 6 to the making of a form fitting bond between a fastener and a solar cell contact, characterised in that a fastener from a metallic substrate with an adding surface from silver and/or. Gold, a solar cell contact from silver and/or. Gold and an intermediate layer from tin and/or. Indium to be used.
8. Process according to claim 7, characterized by the use of molybdenum as metallic carrier for a fastener with an adding surface from silver.
9. Process according to claim 7, characterized by the use of silver as metallic substrate for a fastener with an adding surface from gold.
10. Process according to claim 7, characterized by the use 6 to 10 thicken silver contact layer on the solar cell surface.
11. Process according to claim 7, characterised in that the layer thickness of the tin intermediate layer 1 to 2 amounts to.
12. Process according to claim 7, 8, 9, 10 or 11, characterised in that the intermediate layer from tin and/or. Indium on the adding surface of the fastener from silver or gold is locally applied.
13. Process according to claim 12, characterized by a local applying of the intermediate layer on the adding surface of the fastener by means of photoresist technology (photoresist technology.
14. Process according to claim 12, characterised in that the intermediate layer by a local vaporization by mask technology is brought on the adding surface of the fastener on.
15. Process according to claim 12, characterized by a local galvanic applying of the intermediate layer on the adding surface of the fastener by means of mask technology.
16. Process according to claim 7, 8, 9, 10 or 11, characterised in that the intermediate layer from tin and/or. Indium on the adding surface of the solar cell contact from silver and/or. Gold locally one applies.
17. Process according to claim 16, characterized by a local applying of the intermediate layer on the adding surface of the solar cell contact by means of photoresist technology (photoresist technology).
18. Process according to claim 16, characterised in that the intermediate layer by a local vaporization by mask technology on the adding surface of the solar cell contact is applied.
19. Process according to claim 16, characterized by a local galvanic applying of the intermediate layer on the adding surface of the solar cell contact by means of mask technology.
20. Process according to one of claims 8 to 19, characterised in that of the fasteners, the intermediate layer and the contact to one the soldering temperature corresponding fusing temperature of the intermediate layer within a range from 160 to 325 C for one period from 4 to 10 min to be warmed up that for this period given contact pressure between fasteners, intermediate layer and contact between 10 and 100 Newton amount to.
21. Process according to one of claims 8 to 20, characterised in that before the intermediate layer a thin diffusion barrier layer is separated, which a reaction between carrier metal and the intermediate layer during the storage prevented and thus an improvement permits the shelf-life.

▲ top